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Stratigraphy and Structure of the Knox Dolomite in the Fair Garden Area, Sevier and Jefferson Counties, Tennessee

James Gerald Bumgarner

To the Graduate Council:

I am submitting herewith a thesis written by James Gerald Bumgarner entitled "Stratigraphy and Structure of the Knox Dolomite in the Fair Garden Area, Sevier and Jefferson Counties, Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in .

, Major Professor

We have read this thesis and recommend its acceptance:

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

STRATIGRAPHY AND STRUCTURE OF THE KNOX DOLOMITE IN THE FAIR GARDEN AREA, SEVIER AND JEFFERSON COUNTIES, TENNESSEE

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

by

James Gerald Bumgarner

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ACKNOWLEDGEMENT

It was a pleasant experience to note how so many people cheerfully assisted the author in every phase of the following investigation. Especial credit goes to J. W. Odell who suggested the problem. C. R. L. Oder gave freely of his time and experiences, as well as making several trips into the mapped area. Most of the fossils were identified by members of the United States Geological Survey, Paleontology and Stratigraphy Division.

The members of the faculty of the Department of Geology and Geography of the University of Tennessee reviewed this thesis and made many helpful criticisms. G. W. Swingle and H. J. Klepser suggested mapping technique and methods while visiting the Fair Garden area.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Location and Size of Area

The Fair Garden anticline extends from a point about three miles south of Sevierville, Tennessee, to the northeast for some sixteen miles. (See figure 1). The outcrop area of Knox sediments in this structure comprises approximately fifty square miles.

Statement of the Problem

The problem with which this thesis is concerned is two fold. First, and most important, is to see if recognition of the Knox formations, as mapped in belts to the west, is possible here, where the limestone content is greater. Secondly, if subdivision is feasible, the problem is to determine the structural features.

Previous Investigations

Work of Safford and Keith

The Knox dolomite was named by Safford in 1869. He considered the dolomite sequence the topmost member of his "Knox or Knoxville group". Beneath the dolomite was the "Knox sandstone" (now the Rome formation) and

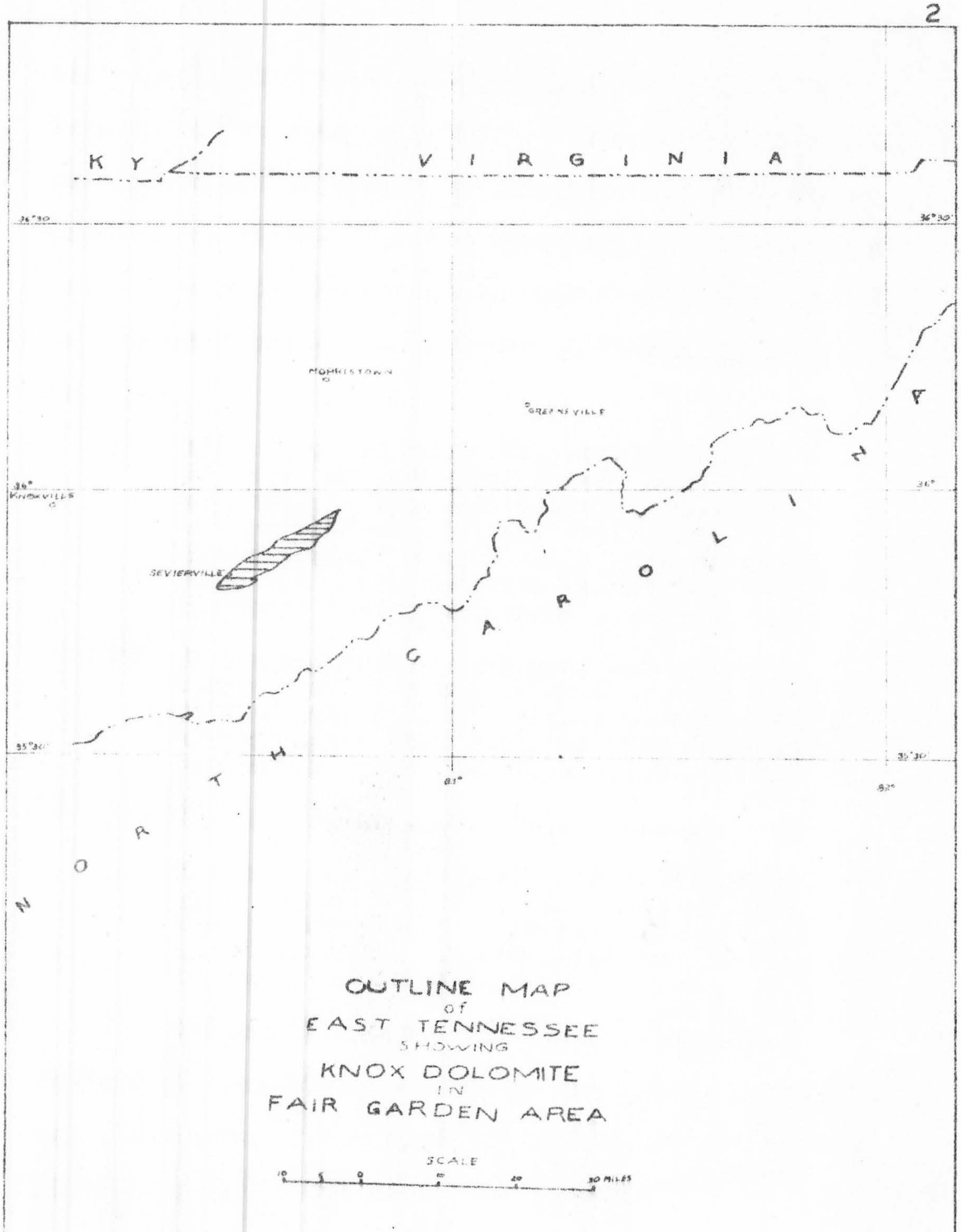
KY
VIRGINIA
36°30'
36°
35°30'
MORRISTOWN
KNOXVILLE
SEVIERVILLE
NORTH CAROLINA
OUTLINE MAP
of
EAST TENNESSEE
SHOWING
KNOX DOLOMITE
IN
FAIR GARDEN AREA
SCALE
10 5 0 10 20 30 MILES
ODER 1934

FIGURE I

the "Knox shale" (now the Conasauga shale). It is interesting to note that Safford was aware that the dolomite could be mapped by utilizing its characteristic chert float. Safford apparently measured but a few sections of the dolomite. His description of the type section along Second Creek at Knoxville, Tennessee, follows:

(a) Limestone and dolomite, mostly blue, but some of the upper strata dark gray and sparry; the blue is partly compact and partly oolitic; the lower part is interstratified with shale thus running into the shale division below; fossiliferous; entire thickness .... 650'

(b) Dolomite, mostly dark gray and sparry, heavy bedded; contains more or less chert throughout, some of which approaches sandstone; upper part includes gray dolomite; thickness ....1870'

(c) Chert .... 4'

(d) Dolomite and limestone, mostly light gray sparry dolomite, with more or less chert throughout; upper part interstratified with blue layers which are fossiliferous; thickness .... 980'

Entire thickness ....3504'

Safford did not state the age of the Knox, although in his discussion of its fauna he implied it was perhaps Mississippian or older.

Arthur Keith (1895), who later studied the Knox, considered the entire dolomite sequence Silurian,[1] although

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[1]Keith's mapping was done before the Ordovician period had been accepted.

he recognized Middle Cambrian fossils in its lower part. The thickness of 3500 feet determined by Keith closely corresponds with Safford's measurement. Keith (1895), describing the formation, writes,

> a great series of blue, gray, and whitish limestones and dolomites. Many of the beds are banded with thin, brown, siliceous streaks and are very fine-grained and massive. Within these beds are nodules of black chert. Their variations are the only changes in the formation. The cherts are most conspicuous in an east west belt across the northern part of the area.

Keith, evidently impressed by the small amount of earthy matter (5 to 15 per cent) in the thick carbonate sequence, reasoned that deposition must have been very slow, perhaps involving more time than any other Appalachian formation.

Subdivision of the Knox Dolomite

Ulrich, in 1911, first proposed subdivision of the Knox dolomite. The work of Ulrich was followed by that of Butts (1933), Hall and Amick (1934), Oder (1934), Bridge (1945), Oder and Miller (1945), and Rodgers and Kent (1948). Much of the Knox in East Tennessee was mapped and subdivided by Bridge and Oder. Their terminology has been accepted by many geologists in the area.

CHAPTER II

SURFACE FEATURES

Topography

Erosion of the Knox dolomite in the Fair Garden area has formed a broad valley. Within this valley, several ridges are present. These ridges are usually underlain by resistant beds of the Longview or by the basal Chepultepec sandstones. However, a few ridges, particularly near Hodsden Bridge in the Richardson Cove quadrangle, result from stream alluvium. The strike of these alluvial ridges bears no relation to structural trends.

The most striking topographic feature in the Knox valley is Little Mountain, located about nine miles northeast of Sevierville. This mountain, although composed of the easily eroded Knox dolomite, stands about 1,000 feet above the valley floor. The presence of this anomalous topographic feature can be explained by assuming it was once capped by Cambrian or older clastics which may have been thrust over the Knox dolomite. These clastics would provide an effective shield against erosion similar to that on English Mountain in the northeastern part of the area.

Sink holes and caves abound in this area of carbonate beds. Usually, the sinks are randomly distributed, but occasionally a lineation of several sinks exists. This alignment of sinks is suggestive of structurally controlled solution.

Drainage

Drainage in the Fair Garden area is into the French Broad, Little Pigeon and East Fork Rivers systems. The streams originate in the mountainous region which lies to the east. Deposits of river alluvium, composed of fragments of the Cambrian and Precambrian sediments, are widespread along the stream courses.

As in most other humid areas, these carbonate sediments are soluble enough so that considerable underground drainage has developed. This type of drainage system is better developed along the northwestern flank of the anticline as evidenced by the abundance of sinkholes.

CHAPTER III

STRATIGRAPHY

Introduction

The lowest stratigraphic unit that is recognizable in the Fair Garden structure is the thick, basal Chepultepec sand. The oldest guide fossil found is <u>Lecanospira</u>. These observations indicate that only the Early Ordovician portion of the Knox is exposed; therefore, no Cambrian Knox is discussed.

The top of the Knox is sometimes marked by a thin conglomerate that appears to represent the same unconformity known to exist at this horizon in the western belts. On top of this unconformity, the Lenoir limestone has been deposited.

Chepultepec Formation

<u>Name and Stratigraphic Relationships</u>

Ulrich (1911) originally applied this name, for the the town of Chepultepec (now Allgood), Blount County, Alabama, to the "Upper Knox".[1] No further detailed work has been done in the type locality, even though

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[1] At first Ulrich named the beds <u>above</u> the "Upper Knox," Chepultepec. This error was partly corrected in a revised correlation table published a few years later.

the area is included in the Birmingham quadrangle mapped by Butts in 1910.

In mapping the quadrangles south of the Birmingham quadrangle, Butts (1927) subdivided the Knox dolomite and established the position of the Chepultepec formation as directly overlying the Copper Ridge dolomite and underlying the Longview formation. This stratigraphic position for the Chepultepec is now generally accepted.

In the Fair Garden area, the Chepultepec is identified chiefly by stratigraphic position and by the presence of a thick basal sand known to occur in the formation in belts to the west. No distinctive Chepultepec fossils were found in the Fair Garden area.

Thickness and Stratigraphic Limits

No measurable sections of the Chepultepec were found in this area. Numerous minor folds prevent accurate thickness calculations, but it is believed the formation is about 900 feet in thickness. This is slightly more than the thicknesses reported in some of the western belts.

The base of the Chepultepec is not exposed in the Fair Garden anticline, but it must be very near the surface as suggested by a quarry exposure of some twenty feet of cross-bedded sandstone. (See figure 2). This

Explanation of Figure 2

The basal Chepultepec sand exposed in an abandoned quarry near Bird Crossroad. The pick is resting on one of the foreset beds. The surfaces dipping to the left of the photograph are bedding planes.

The sand in this locality is over twenty feet thick. The cross beds indicate that the sediments came from the north.

FIGURE 2

quarry is just south of Bird Crossroad and is situated on the crest of the anticline.

The top of the Chepultepec is based on a change in lithology. It is marked by a fairly sharp change from the dark gray limestone to the light gray, fine-grained dolomite of the Longview formation. No unconformity is recognized at this horizon.

Lithology

The Chepultepec in the Fair Garden area is composed principally of limestone; relatively few dolomite beds are present. The limestone is usually dark gray, and very fine-grained. It commonly breaks with a conchoidal fracture. Beds are one to six feet thick and, in places, separated by thin green or black shale partings. These partings are one-eighth to one-fourth inch thick.

Sand grains are scattered throughout the formation. These grains are usually quartz and are arranged in zones parallel to bedding. They are always frosted, well rounded, and about one millimeter in diameter. The grains in this formation are distinctive, however, differing in color from the other sands in the Knox dolomite. Many of the Chepultepec sands in fresh exposures have a dark gray or black color. This dark color is due probably to the dark color of the limestone matrix reflected in the individual grains.

Thin beds of arenaceous dolomite are often associated with the other dolomite beds. Frequently, these sandy zones show faint cross-bedding, which, to the author, indicates reworking of both the sand and the dolomite matrix.

A thin conglomerate zone occurs near the top of the basal Chepultepec sandstone. The pebbles in this zone are composed of carbonate material, which, on weathering, leaves moulds of the pebbles. This conglomerate zone is known to occur at about the same stratigraphic horizon in other belts of the Knox dolomite.[2]

The cherts of the Chepultepec dolomite in the Fair Garden area are very similar to the Chepultepec cherts of the western belts. The principal difference seems to be in amount. There is much less silica in the formation this far east. An explanation for the marked eastward diminution of silica in the Knox was suggested to the writer by Oder[3] who states that since the Knox basin was receiving sediments from the north and northwest, the colloidal silica and much of the magnesium were deposited quickly upon reaching salt water and that only a minor amount of these materials were carried as far south as the Fair Garden area. There were simply fewer

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[2]This same conglomerate occurs at the top of the Chepultepec sand on State Highway 66 between Rogersville and the John Sevier Steam Plant.

[3]Personal communication, 1956.

sediments that traveled this greater distance so that we have only the chemical precipitants to make up the bulk of the section.

Paleontology

Very few fossils were found in the Chepultepec. Algae were most abundant. (See B, figure 3). Brachiopod fragments and occasional whole shells were found at several localities. *Tritoechia typica* Ulrich was identified by R. B. Neuman.

The scarcity of Chepultepec fossils can be partially explained by lack of outcrops. Chepultepec outcrops are even less abundant than Longview exposures.

The Longview Formation

Origin of the Formation Name

Though the term, Longview, may have been used by Nelson previously, the Longview formation was first described by Butts (1926) as the Longview limestone. He named the formation for Longview, Shelby County, Alabama. Butts failed to describe a type section, probably because the upper and lower boundaries are not well exposed at Longview.

Bridge reintroduced the name into Tennessee as a substitute for the name, Nittany dolomite, that had previously been used for the same formation. Consequently, the name, Longview, has come to be regarded as the formational name for the dolomite beds between the Kingsport and the Chepultepec formations in Tennessee.

The difficulty Butts had in Alabama because of the poorly exposed contacts is tremendously magnified in Tennessee where no well developed upper or lower contact is present even when good exposures can be found. This has led investigators to report thicknesses for the Longview of from twenty-five feet to five hundred and fifty-four feet. (Oder, 1934, p. 482).

Formational Limits

Upper contact. The variance in reported thicknesses of the Longview emphasizes the difficulty in establishing both the upper and lower formational contacts of the formation in Tennessee. In the Fair Garden area the contact must be placed at either the base of the "dry breccia" or at the change (gradational) in lithology, 240 feet stratigraphically higher. (See footnote 1, p. 26). The author chose to place the upper contact at the change in lithology, at least until the "dry breccia" is better understood and possibly proven to be a regional unconformity. It should be noted that no specimens of *Lecanospira* have been found in the mapped area between the "dry breccia" and the change in lithology stratigraphically above.

Basal Longview contact. It is realized that in other Knox belts, the Longview lithology (i.e., fine-grained, well-bedded, light gray dolomite beds) extends down into the Chepultepec dolomite, but in the Fair Garden area the Chepultepec formation seems to be almost completely limestone. The basal Longview contact is placed at this change in lithology from limestone to fine-grained dolomite since no faunal evidence was found to the contrary.

Lithology and Thickness

The stratigraphic thickness of the Longview formation in the Fair Garden area appears to be about 650 feet, but nowhere is a complete section exposed. The two best sections found were the partial section of lower Newala and upper Longview near Hodsden Bridge across the Pigeon River, and the Pigeon River section along the banks of the river near Murphys Chapel. (See figures 14 and 15).

As can be seen from these sections, the Longview contains only a few thin limestone beds at the top. The remainder of the formation is composed of almost equal amounts of fine-grained, massive dolomite containing numerous sandy zones, and thin to massive beds of fine to coarsely crystalline dolomite shown as "recrystalline dolomite" on the stratigraphic sections.

Many zones of nodular or bedded chert, two to four inches thick, occur in the Longview; but none of the thick, massive chert beds so typical of the formation in the western Knox belts were observed. The chert in the "recrystalline dolomite" is quite angular, as though the chert nodules had been broken and the individual fragments rotated or displaced.

The sand grains and sandstone layers in the Longview are quite similar to those found elsewhere in the Knox dolomite. The grains are well rounded, frosted, and up to one millimeter in diameter. The quartz grains usually are clustered in zones or layers measuring from a few inches to a foot thick, but close examination of any fresh exposure will usually reveal one or two isolated grains.

Topographic Expression of the Longview

Even though the Longview in the Fair Garden area contains less than one-third as much chert as it does in the western belts, the formation still contains relatively more chert than the adjoining formations. The resultant topographic expression is the same as in the western Knox belts, low lying ridges covered with typical Longview chert, but displaying very few outcrops.

Paleontology

Probably the most important and characteristic fossil found in the Longview formation is the specimen of Lecanospira shown in figure 3A. Geographically, Lecanospira is a wide spread gastropod whose presence in the Fair Garden area, coupled with the typical Tennessee Longview lithology, would seem to definitely establish the presence of this formation.

Explanation of Figure 3

A. *Lecanospira* in a piece of Longview chert found in float north of Bird Crossroad.

B. Stromatolite type fossil that has been partially replaced by chert.

A

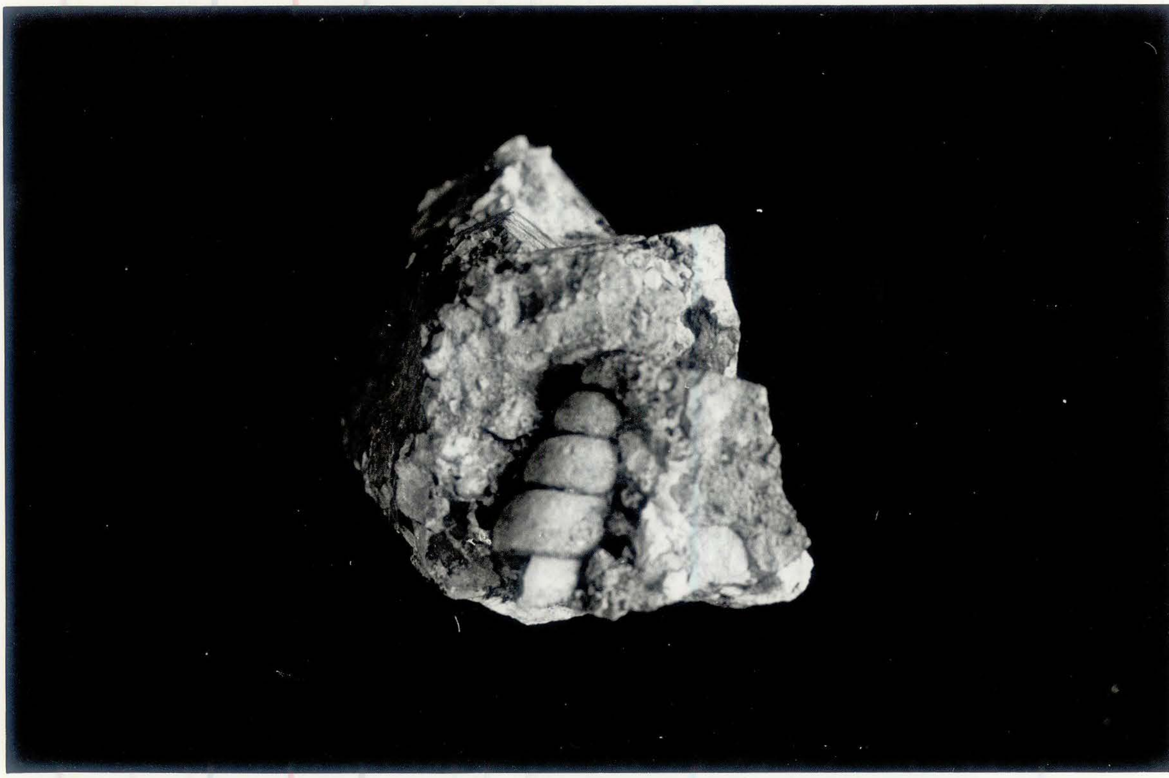
B

FIGURE 3

Explanation of Figure 4

A. <u>Hormotoma</u> sp. from chert float near the Newala-Longview contact.

B. A large gastropod in Longview chert.



A

B

FIGURE 4

Other fossils found in the Longview are the gastropod in figure 4B and possibly the Hormotoma shown in figure 4A which was found in chert float near the Longview-Newala contact.

Newala Formation

Name and Stratigraphic Relations

The topmost subdivision of the Knox dolomite in the Fair Garden area is herein called the Newala formation. Fossil evidence and stratigraphic position indicates that the unit is correlative with the Newala of Alabama as described by Butts (1926). Newala is here used in preference to Kingsport and Mascot because fossils considered indicative of each formation were found to occur together.

Lithologic Nature

Approximately 45 per cent of the Newala is dolomite in the Fair Garden area. (See figure 14). This dolomite varies in color from very light gray to a dark bituminous gray. It is fine- to medium-grained, with cross-bedding present in several exposures. (See figure 5). This feature is particularly conspicuous on weathered outcrops and would seem to indicate a clastic origin for some of the dolomite. Quartz sand grains are commonly present in thin zones with a dolomite matrix.

Limestone beds are abundant in the Newala. Occasionally a gradational zone exists between the limestone and dolomite layers but usually the contact is sharp, being marked by a thin shale parting. The limestone beds range from one foot to thirty-two feet in thickness. Individual beds appear to be generally consistent in thickness throughout the area. Three types of limestone are present and one type may grade into the other. The first is a detrital type containing rounded limestone fragments up to one inch in diameter, oolites, occasional sand grains, and shell fragments. The second type is very fine-grained with numerous anastomosing thin shale partings one millimeter and greater in thickness. A third type, less abundant than the other types, contains irregular areas of dolomite. In many cases the dolomite content is highest at the base of a given bed.

Several unusual features are present in the Newala rocks. For example, sandstone layers occur almost exclusively in the dolomite beds. The sandstone beds range from less than an inch to over four feet in thickness.

One of the prominent sandstone beds, referred to here as the "four foot sand", was selected as a marker bed. (See figure 5). This bed occurs approximately 220 feet below the top of the formation. The quartz sand grains are not closely packed but rather are separated

Explanation of Figure 5

This photograph shows the "four foot sand" exposed along a road cut one-half mile northwest of Cedar Bluff Community.

The cross-bedded nature of the sand is well brought out by weathering. Many small cavities show where carbonate pebbles have been dissolved.

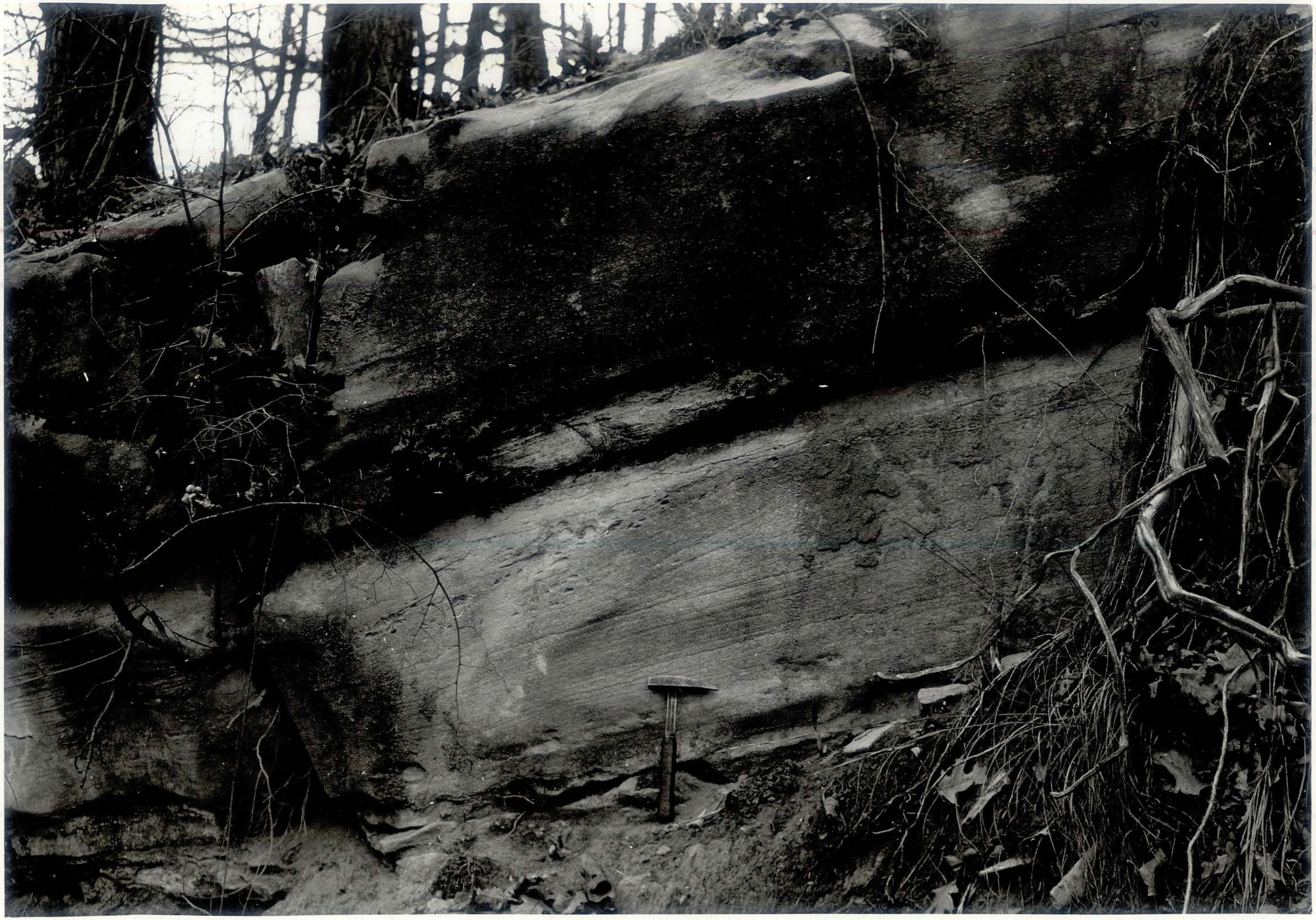


FIGURE 5

by the dolomite matrix. On weathering, the quartz sand grains stand in relief and the cross-bedded nature of the rock is well displayed.

Another interesting feature is the absence of fossils in dolomite beds; all fossils observed in bed-rock occured in the limestone beds. It is suggested that the absence of fossils in the dolomite beds is due to the clastic origin of the dolomite, reworking and destroying any fossils which may have been present. Also unusual is the abundance of mud cracks and ripple marks in several dolomite beds. Small pit-like structures resembling rain drop impressions occur on some bedding planes, but the significance of these features is unknown.

Two prominent zones of chert occur in the Newala; one, forty feet above the "four foot sand", and a second, thicker zone, about 200 feet beneath the marker. The chert occurs both as nodules and in beds. The nodules are usually gray and concentrically banded. The bedded cherts are oolitic in places.

The sand grains in the Newala formation are the same as those throughout the Knox dolomite, about one millimeter in diameter, exceptionally well rounded, and always frosted.

Stratigraphic Limits

The top of the Newala is marked by an unconformity. This is usually recognized by a conglomerate containing reddish-gray, rounded dolomite pebbles and in places, angular chert fragments; but occasionally, only a sandy zone or a change in lithology is present. This change is easily found since the nodular Lenoir limestone at the base of the Sevier shale is in contact with the fine-grained limestone or dolomite of the upper Newala.

The base of the Newala is difficult to determine. The writer used the change in lithology from the limestone and dolomite beds of the Newala to the fine-grained, light gray dolomite beds of the Longview, and the change in type of chert to establish this basal contact.

It must be pointed out, however, that the same "dry breccia"[1] known to exist in the upper Longview of many of the western belts is well exposed in the Fair Garden area and may represent a basal Newala conglomerate. This "dry breccia" is composed of angular or subangular blocks of fine-grained, light gray dolomite, as well as numerous chert fragments, in a matrix of crystalline dolomite. Upon slight weathering, the texture is etched into relief.

Because of the erosion surface at the top of the Newala formation, its thickness is quite variable. For

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[1]This breccia was first brought to the writer's attention by C. R. L. Oder in the Mascot-Jefferson City district. Oder observed this same type breccia at about the same stratigraphic position in other belts of the Knox in East Tennessee. Since this breccia is well developed throughout the Fair Garden belt, it may represent a basal conglomerate and therefore be lowermost Newala.

example, in the Hodsden Bridge section, located three miles east of Sevierville, on the Pigeon River, the stratigraphic thickness is 555 feet. (See figure 14). In the Lane Hollow section, only one-half mile to the northeast, the stratigraphic thickness is fifty-five feet thinner.

Paleontology

The Newala formation in the Fair Garden area is relatively fossiliferous. Gastropods are most abundant but are seldom identifiable. The most abundant identifiable fossils are members of the Ceratopea group. Figures 6, 7, and 8 show several of these species. Oddly, these same fossils presented a problem in stratigraphy, for Ceratopea capuliformis Oder, which is considered a Kingsport fossil, was found in float very near to the upper Newala contact under conditions where it could not have come from beds below the "four foot sand".

On the other hand, Ceratopea keithi Ulrich and C. tennesseensis Oder occur well below the "four foot sand", but above a sponge, Archaeoscyphia, which is considered lower Jefferson City and therefore lower Kingsport. The intermingling of key fossils makes subdivision into the Kingsport and Mascot formations impossible and left the alternative of naming the entire unit the Newala formation.

A list of the identified Newala fossils is as follows: Ceratopea capuliformis Oder[2], C. keithi Ulrich, C. subconica Oder, C. tennesseensis Oder, Tritoechia typica Ulrich,[3] Hormotoma sp. (found in float near the Newala-Longview contact), Orospira sp., and Archaeoscyphia sp.[4] (tenative field identification only).

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[2] All Ceratopea specimens were identified by E. L. Yochelson, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

[3] Identified by R. B. Neuman, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

[4] Field identification by W. J. Sando, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

Explanation of Figure 6

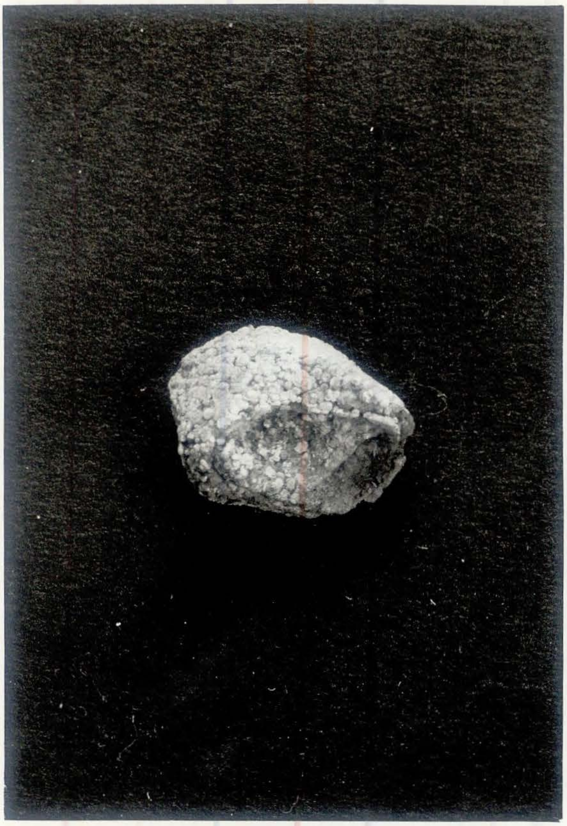
A. Ceratopea tennesseensis Oder collected in place only a few feet below the top of the Newala formation.

B. Specimens of Tritoechia typica Ulrich leached from limestone in the Newala formation. (See stratigraphic section, figure 14).

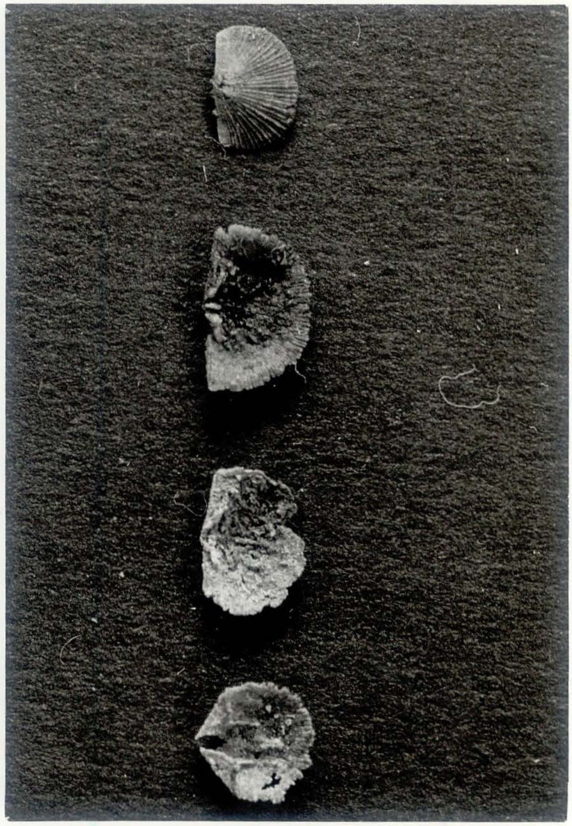
C. Ceratopea sp. (probably C. keithi Ulrich).
Ceratopea keithi Ulrich
Ceratopea keithi Ulrich

Collected in float overlying the Newala formation.

D. Siphuncles replaced by chert found in float overlying the Newala formation.



A



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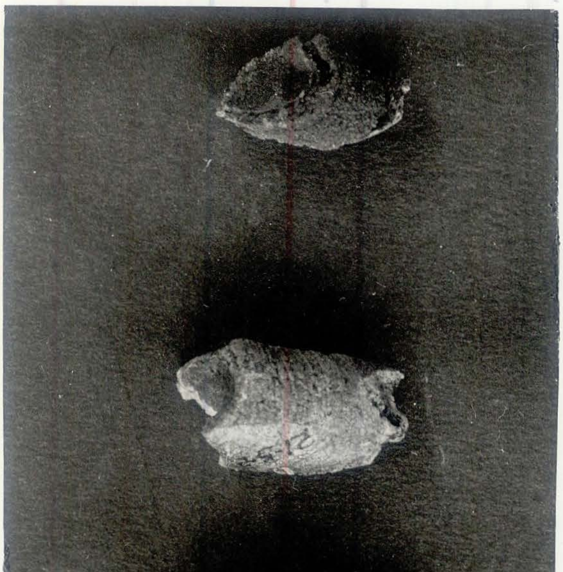
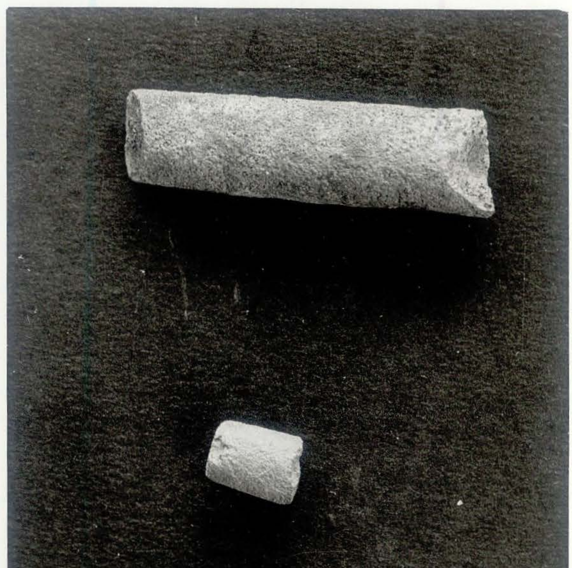


C



D

FIGURE 6

Explanation of Figure 7

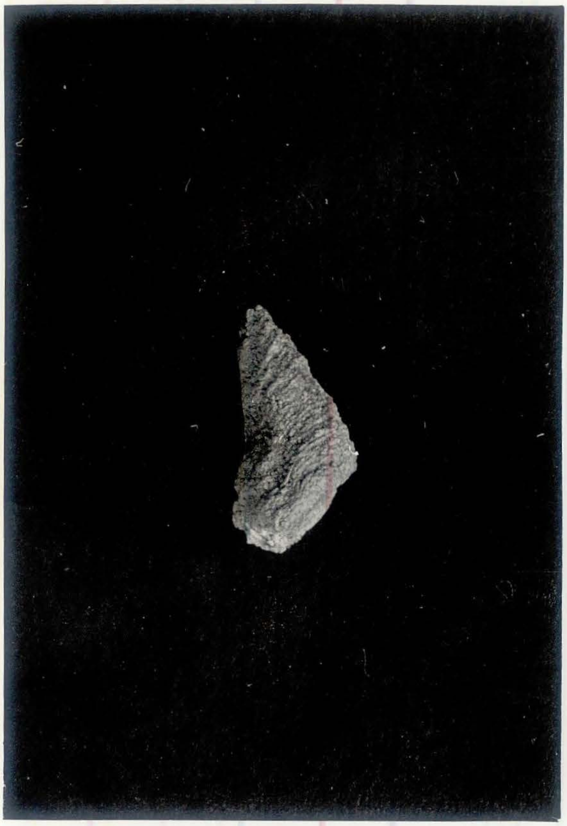
A. Ceratopea cf. C. tennesseensis Oder
Collected in place from the Newala formation stratigraphically below the "four foot sand" near Roberts School, west of the Pigeon River.

B. Partially silicified cephalepods (probably Cassinoceras) collected from float high in the Newala formation.

C. In decending order, Ceratopea subconica Oder
Ceratopea keithi Ulrich
Ceratopea subconica Oder
All these species were found in place along the east fork of the Little Pigeon River. (See stratigraphic sections of Newala formation).

D. Left column, in decending order,
Ceratopea sp.
Ceratopea cf. C. tennesseensis or C. keithi Ulrich
Ceratopea capuliformis Oder

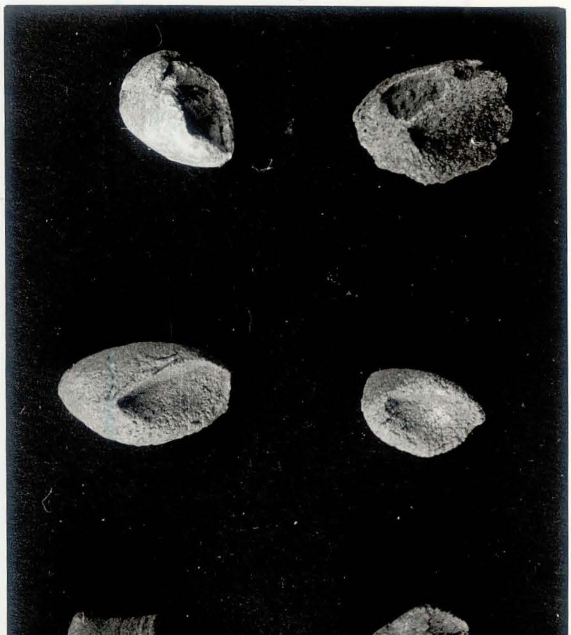
Right column, in decending order
Ceratopea cf. C. tennesseensis Oder
Ceratopea tennesseensis Oder
Ceratopea cf. C. capuliformis Oder
The fossils in D were collected in float at a locality where they had to emerge from beds above the "four foot sand" of the Newala formation.



A

B

C



D

FIGURE 7

Explanation of Figure 8

Newala Gastropods

Left column,
In decending order,
Ceratopea keithi Ulrich
Ceratopea keithi Ulrich
Ceratopea subconica Oder
Ceratopea subconica Oder

Right column,
In decending order,
Ceratopea keithi Ulrich
Ceratopea subconica Oder
Ceratopea keithi Ulrich
Ceratopea keithi Ulrich
Ceratopea subconica Oder

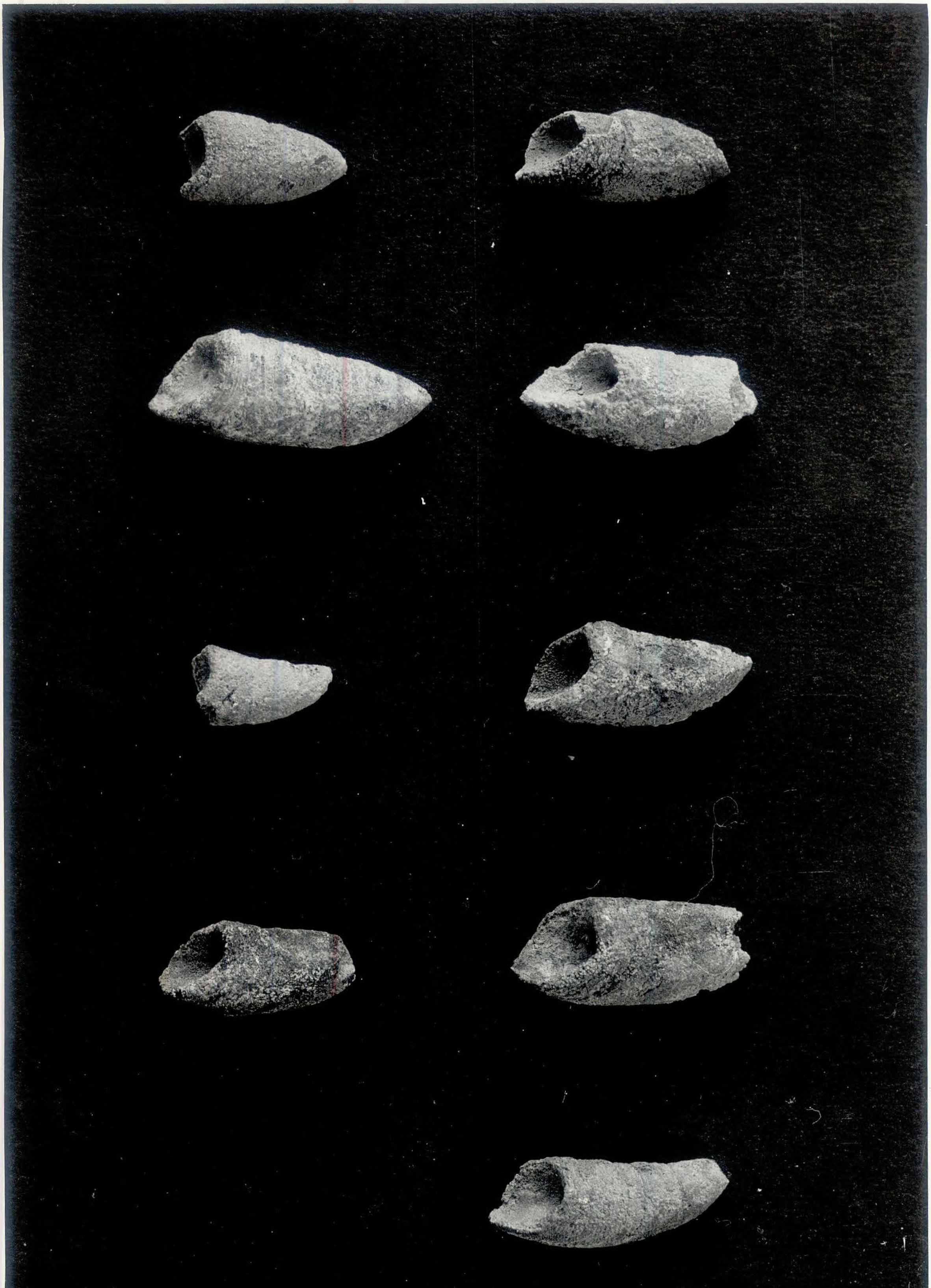


FIGURE 8

CHAPTER IV

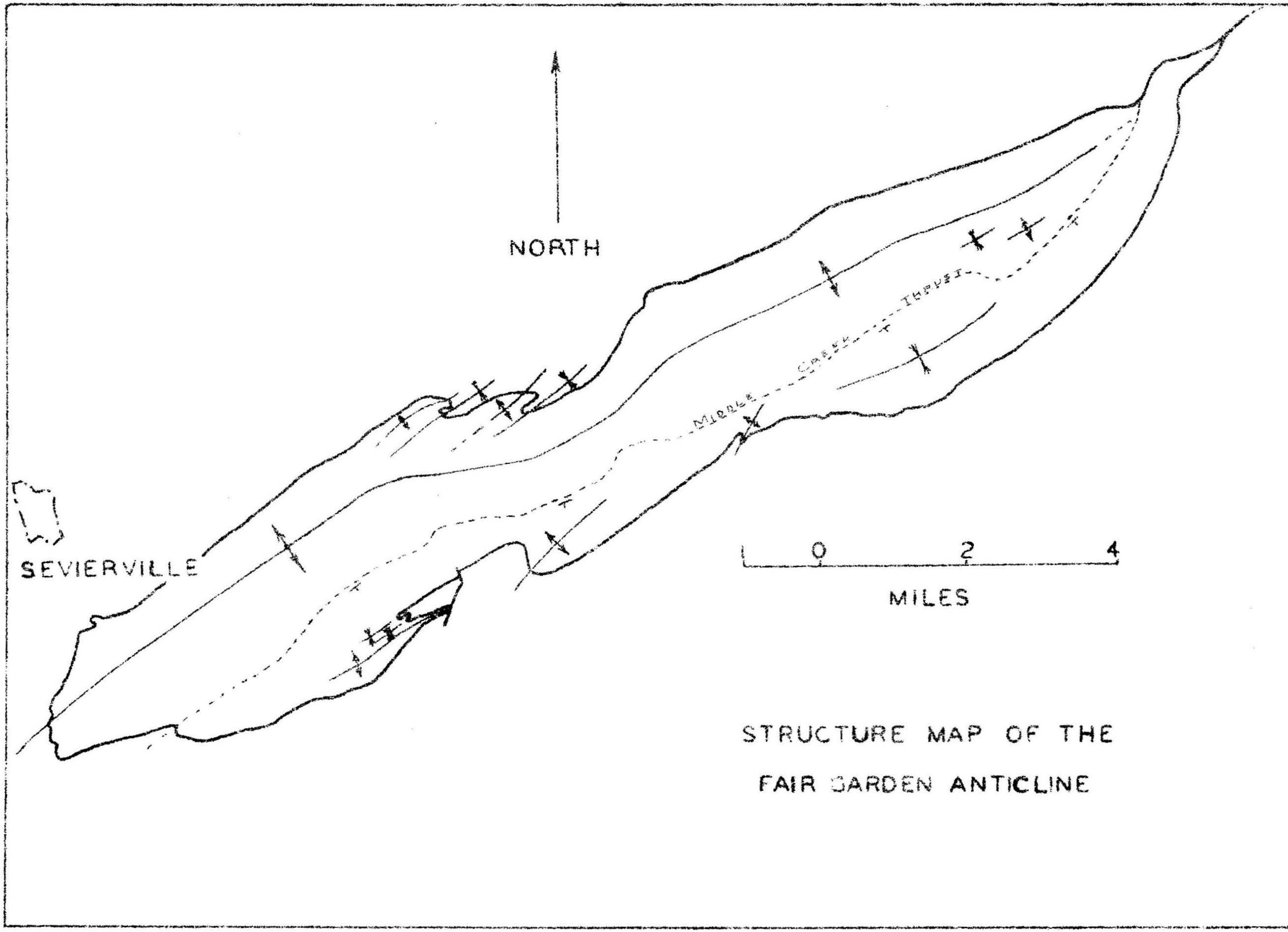
STRUCTURE

General

Two prominent structural features exist in the Fair Garden anticline area, one the anticline itself, and secondly, the Middle Creek fault which extends the length of the area. Minor folds and faults are also present.

The Fair Garden Anticline

This anticline was named for the community of Fair Garden, which is located about midway along the strike of the structure. The anticline is sharply asymmetrical, with dips along the northwest flank ranging from sixty-five to eighty-seven degrees; those on the southeast flank range from fifteen to twenty-five degrees. Except in the vicinity of Fair Garden, the trace of the crest of this anticline is very straight. In the Fair Garden area, however, the axis swings southward because of many small synclinal structures. (See figure 9). To the northeast of Fair Garden Community, the trace of the crest again trends in the regional direction (northeast) but it now has a more southeasterly position than was found in the area east of Sevierville.



STRUCTURE MAP OF THE
FAIR GARDEN ANTICLINE

FIGURE 9

Middle Creek Thrust Fault

This fault is named for the community of Middle Creek, Sevier County, near the southwestern end of the area. The dip of the fault plane is probably similar to the formation dips on the southeastern flank of the anticline. Nowhere is the fault plane exposed.

The inferred existence of this fault is based solely on the repetition of formations. Along most of the strike length, the Newala and part of the Longview is repeated. It was first thought that folding had been responsible for this repetition, but detailed field examination proved that this was not the case. The thrust fault was then picked as the most probable explanation and could not be disproved under detailed field mapping.

Minor Structures

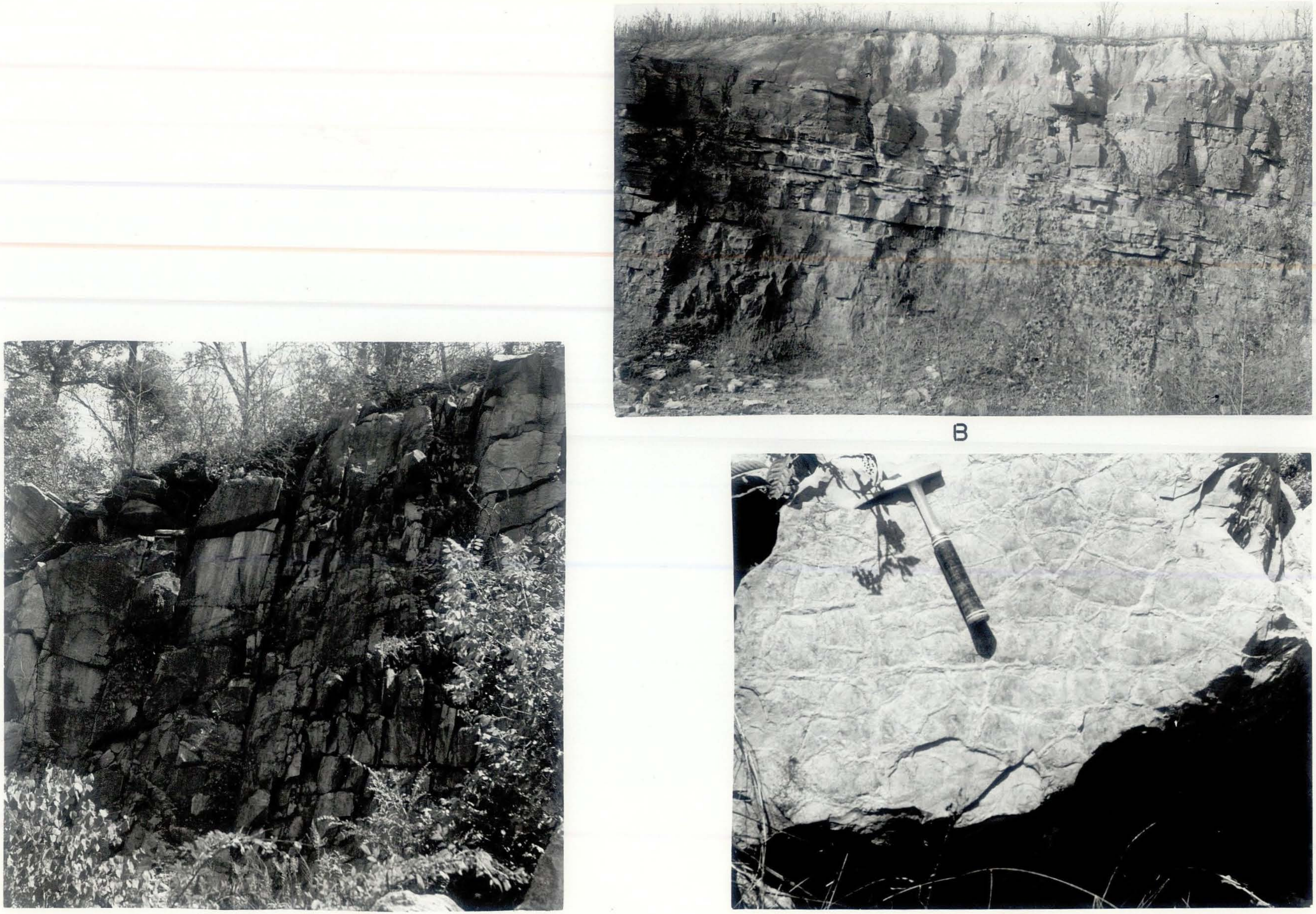
Numerous small folds associated with the Fair Garden anticline were not noted in the earliest reconnaissance mapping of the belt. (Keith 1895). Later more detailed mapping on better base maps brought out the many small synclines and anticlines superimposed on, and parallel to, the major anticlinal structure. (Rodgers 1953). These folds are conspicuous along the Lenoir-Newala contact northeast of Fair Garden Community and

Explanation of Figure 10

A. The near vertical dip of the Newala beds on the northwest flank of the anticline.

B. The gentle dip on the southeast flank of the anticline.

C. "Fossil" mud cracks in dolomite.



B

A

C

FIGURE 10

Explanation of Figure 11

This abandoned quarry, near Chestnut Hill, Tennessee, is located on the crest of the Fair Garden anticline. The beds on the left side of the photograph (southeast) are nearly flat, those on the right side (northwest) are dipping steeply.

FIGURE II

GEOLOGIC STRUCTURE SECTIONS

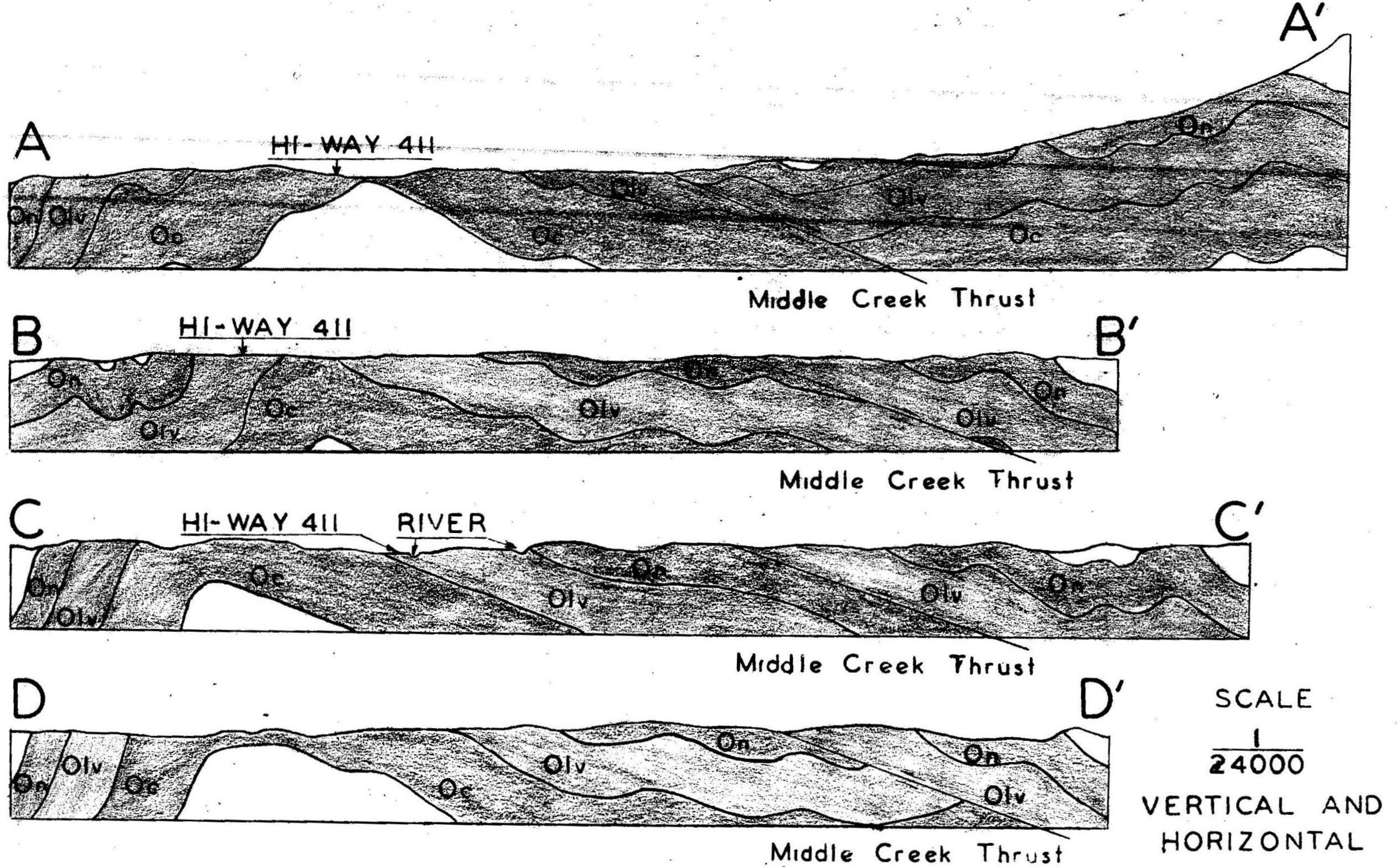


FIGURE 12

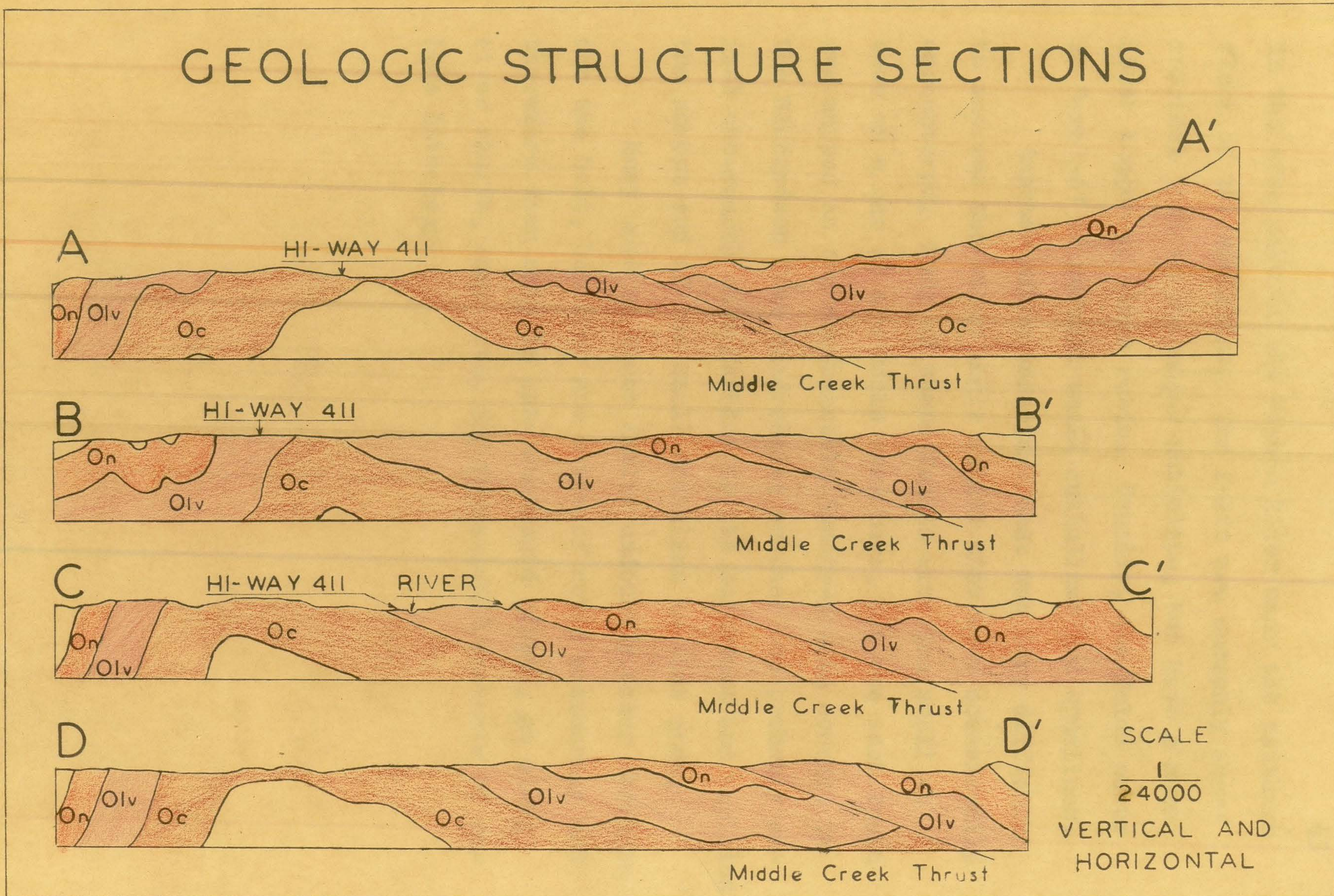

GEOLOGIC STRUCTURE SECTIONS
A
A′
HI-WAY 411
On
Olv
Oc
Middle Creek Thrust
B
B′
HI-WAY 411
On
Olv
Oc
Middle Creek Thrust
C
C′
HI-WAY 411
RIVER
On
Olv
Oc
Middle Creek Thrust
D
D′
On
Olv
Oc
Middle Creek Thrust
SCALE
1/24000
VERTICAL AND HORIZONTAL

FIGURE 12

in the area east of the Pigeon River near the southern flank of the anticline. The folds are commonly asymmetrical just as the major anticline, but have a much lower length to width ratio. Usually, the folds occur in "groups" of several small anticlines and synclines.

Another minor structure that was very difficult to map was the steep angle faults that were occasionally encountered. Many of these faults were too small to show on a map of the scale used here, but one such fault was mapped on the southeastern Lenoir-Newala contact in the Richardson Cove quadrangle; another one probably exists one-fourth mile farther to the southwest and explains the abrupt end of the small anticline in that area.

Many more of these faults undoubtly occur throughout the belt, but they are zones of rapid weathering and therefore seen only in less weathered places, as along river bluffs, road cuts, and formational contacts of unlike lithology.

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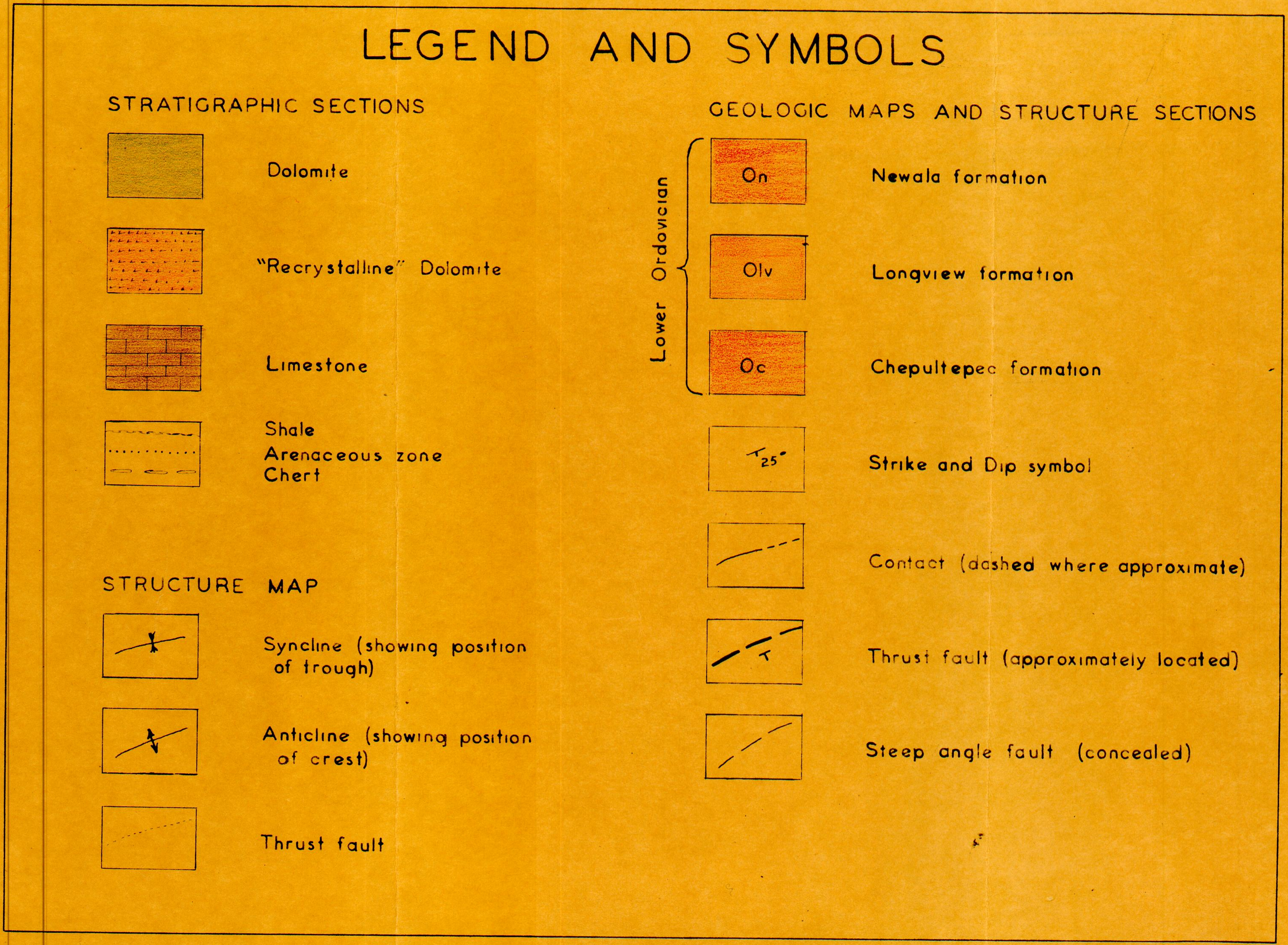
LEGEND AND SYMBOLS
STRATIGRAPHIC SECTIONS
Dolomite
"Recrystalline" Dolomite
Limestone
Shale
Arenaceous zone
Chert
STRUCTURE MAP
Syncline (showing position of trough)
Anticline (showing position of crest)
Thrust fault
GEOLOGIC MAPS AND STRUCTURE SECTIONS
Lower Ordovician
On
Newala formation
Olv
Longview formation
Oc
Chepultepec formation
25
Strike and Dip symbol
Contact (dashed where approximate)
Thrust fault (approximately located)
Steep angle fault (concealed)

FIGURE 13

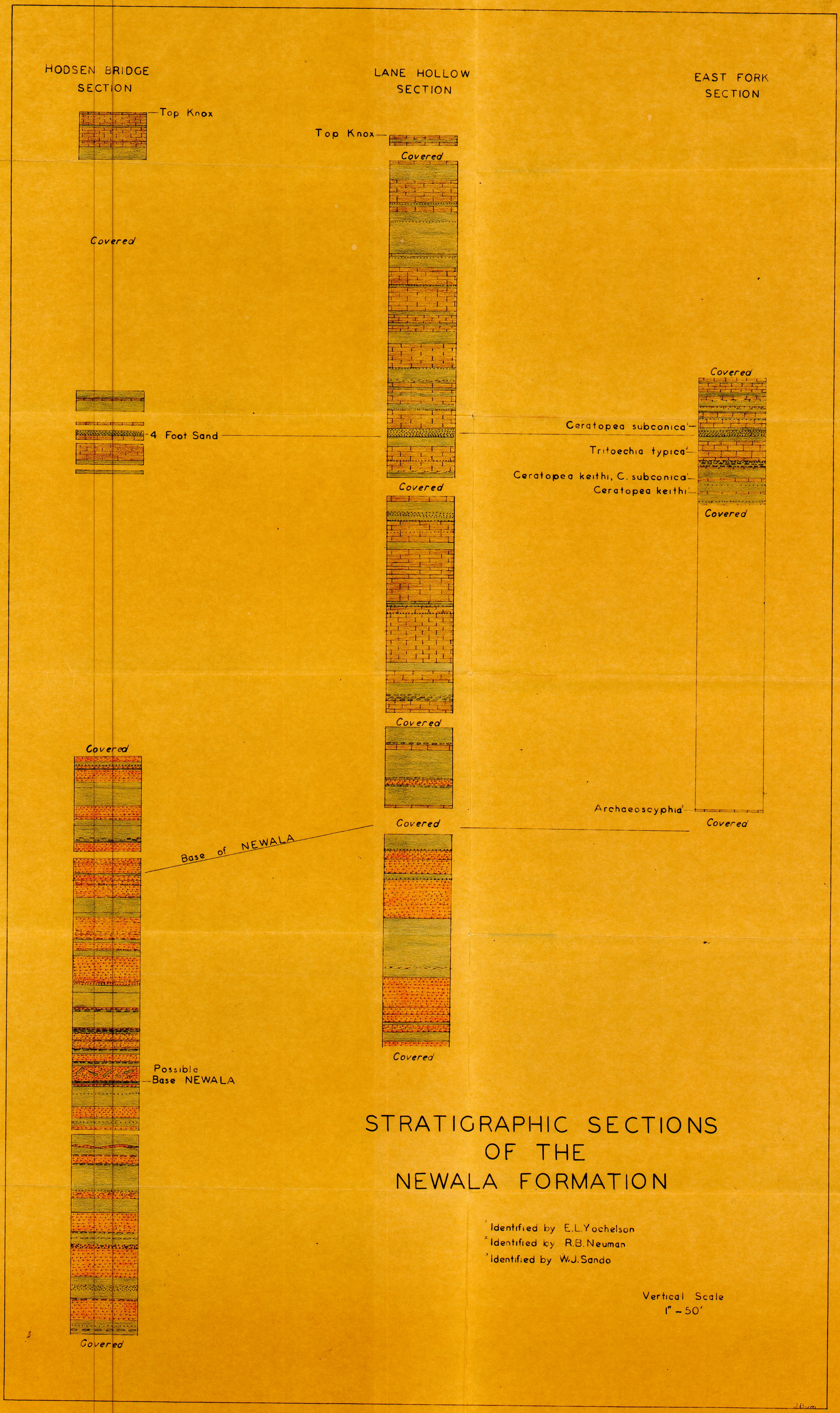
HODSEN BRIDGE SECTION
LANE HOLLOW SECTION
EAST FORK SECTION
Top Knox
Covered
4 Foot Sand
Ceratopea subconica[1]
Tritoechia typica[2]
Ceratopea keithi, C. subconica[1]
Ceratopea keithi[1]
Archaeoscyphia[3]
Base of NEWALA
Possible Base NEWALA
STRATIGRAPHIC SECTIONS OF THE NEWALA FORMATION
[1] Identified by E.L. Yochelson
[2] Identified by R.B. Neuman
[3] Identified by W.J. Sando
Vertical Scale 1" – 50'

Figure 14

STRATIGRAPHIC SECTION
OF PART OF
THE
LONGVIEW FORMATION
ALONG THE PIGEON RIVER

SCALE
1"—50'

FIGURE 15

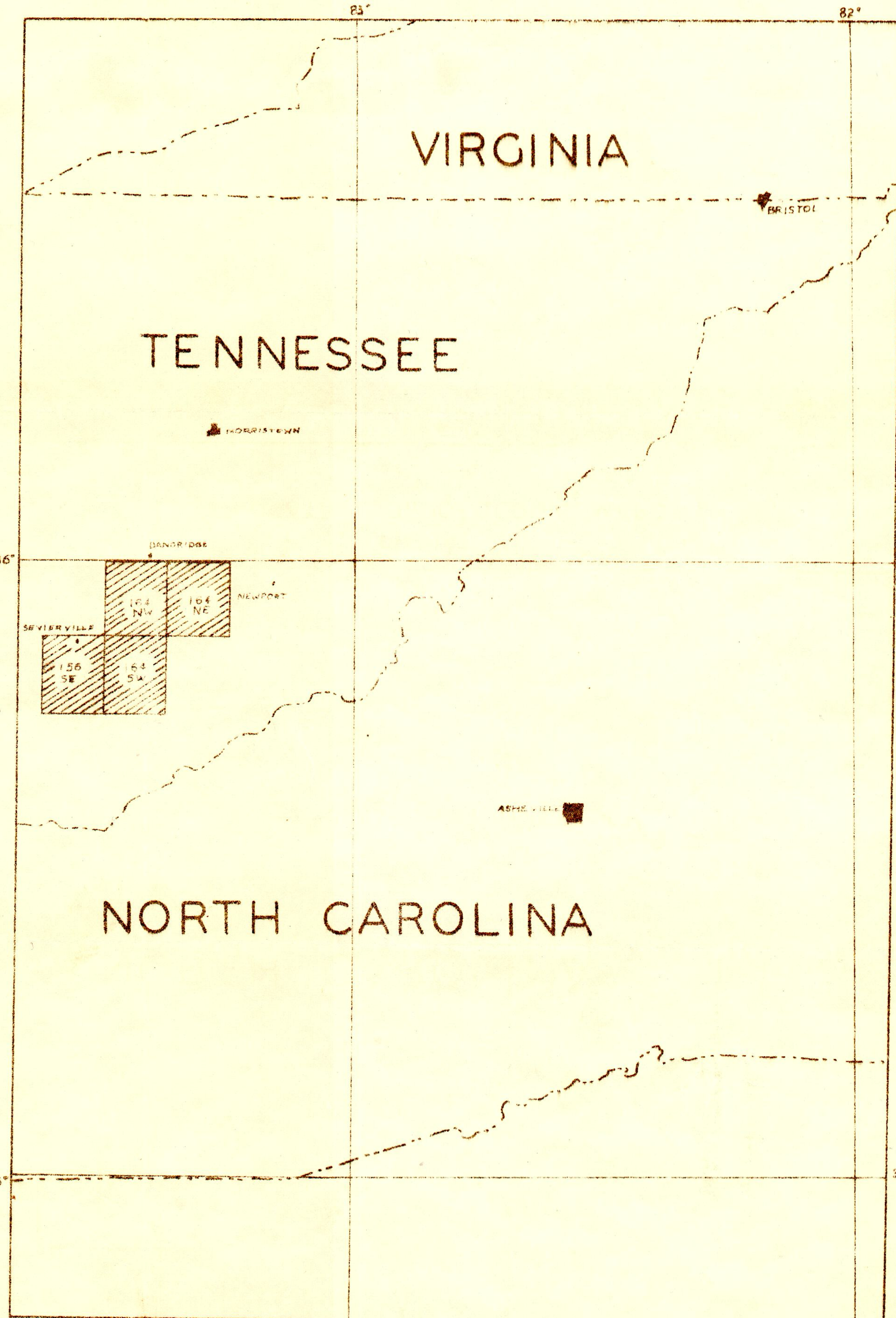

FIGURE 16
LOCATION OF GEOLOGIC MAPS

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

UNITED STATES
TENNESSEE VALLEY AUTHORITY
MAPS AND SURVEYS DIVISION

TENNESSEE
CLEVENGER QUADRANGLE
164-NE

Control by USC&GS, USGS, and TVA.
Topography by Geological Survey from aerial photographs by stereophotogrammetric methods.
Field examination by Tennessee Valley Authority, 1939.

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1939

Scale $\frac{1}{24000}$

1 ½ 0 1 2 Miles
5000 0 5000 10000 Feet
1 ½ 0 1 2 Kilometers

Contour interval 20 feet with 10 foot contours shown by broken line
Datum is mean sea level

Polyconic projection. 1927 North American datum
10,000 foot grid based on Tennessee rectangular coordinate system

Chestnut Hill

CLEVENGER, TENN.
164-NE
Edition of 1940
N3552.5-W8315/7.5
ENGRAVED AND PRINTED BY WILLIAMS & HEINTZ CO. WASH. D. C.

Figure 17 A

UNITED STATES
TENNESSEE VALLEY AUTHORITY
MAPS AND SURVEYS DIVISION

TENNESSEE
SHADY GROVE QUADRANGLE
164 - NW

Control by USC&GS, USGS, and TVA.
Topography by Fairchild Aerial Surveys, Inc.
by stereophotogrammetric process.
Field examination by Tennessee Valley Authority 1939
Office inspection and review by the Geological Survey

Maps distributed by the Geological Survey

Scale $\frac{1}{24000}$

Contour interval 20 feet with 10 foot contours shown by broken line

Datum is mean sea level

Engraved and printed by the Coast and Geodetic Survey

Polyconic projection. 1927 North American datum
10,000 foot grid based on Tennessee rectangular coordinate system

SHADY GROVE, TENN.
164 - NW
Edition of 1939

Figure 17 B

N3552.5-W8322.5 / 7.5

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

UNITED STATES
TENNESSEE VALLEY AUTHORITY
MAPS AND SURVEYS DIVISION

TENNESSEE
(SEVIER COUNTY)
RICHARDSON COVE QUADRANGLE
164 - SW

Control by USC&GS, USGS, and TVA.
Topography by Geological Survey from aerial photographs by stereophotogrammetric methods.
Field examination by Tennessee Valley Authority - 1940.

APPROXIMATE MEAN DECLINATION, 1940

Scale $\frac{1}{24000}$

Contour interval 20 feet
Datum is mean sea level

Engraved and printed by the Coast and Geodetic Survey

Polyconic projection. 1927 North American datum
10,000 foot grid based on Tennessee rectangular coordinate system

ROUTES USUALLY TRAVELED
HARD, IMPERVIOUS SURFACES
OTHER SURFACE IMPROVEMENTS
U. S. ROUTE
STATE ROUTE

RICHARDSON COVE, TENN
164 - SW
Edition of 1940
N3545-W8322.5/7.5

Figure 17 C

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

UNITED STATES
TENNESSEE VALLEY AUTHORITY
MAPS AND SURVEYS DIVISION

TENNESSEE
(SEVIER COUNTY)
PIGEON FORGE QUADRANGLE
156-SE

35°45′
83°37′30″
2,710,000 FEET
35′
(Gatlinburg 157-NE)
32′30″
Preliminary edition, 1940
GATLINBURG 3½ MI.
NEWFOUND GAP 21 MI.
Printed by the Geological Survey
35°45′
83°30′

Control by USC&GS, USGS, and TVA
Topography by Geological Survey from aerial photographs by stereophotogrammetric methods.
Field examination by Tennessee Valley Authority, 1940

Maps distributed by the Geological Survey

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1940

Scale: $\frac{1}{24000}$

1 ½ 0 1 2 Miles
5000 0 5000 10000 Feet
1 ½ 0 1 2 Kilometers

Contour interval 20 feet with 10 foot contours shown by broken line
Datum is mean sea level

Polyconic projection. 1927 North American datum
10,000 foot grid based on Tennessee rectangular coordinate system

ROUTES USUALLY TRAVELED
HARD IMPERVIOUS SURFACES
OTHER SURFACE IMPROVEMENTS
1940
2 U. S. ROUTE
3 STATE ROUTE

PIGEON FORGE, TENN.
156-SE
Figure 17 D
N 3545 – W8330/7.5